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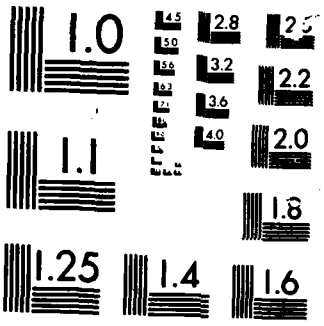

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TESTICULAR CANCER IN U.S. NAVY PERSONNEL

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Testicular Cancer in U.S. Navy Personnel

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Summary

Problem

The risk of the development of testicular cancer is greatest in white men aged 20-29. The U.S. Navy is one of the largest defined populations available of men in this high incidence age group receiving health care through a centralized, computer-based medical records system. For these reasons, and the wide variety of occupational exposures present in the Navy, the Naval Health Research Center initiated a prospective study of the incidence of testicular cancer according to occupation in order to identify any occupational associations that may adversely affect naval readiness.

Objective

The objective of this study was to assess occupational differences in risk for the development of testicular cancer in active-duty enlisted naval personnel during the period 1974-79 compared to the U.S. population and total enlisted naval personnel incidence.

Approach

There were 2,275,829 person-years at risk in white male enlisted personnel involved in approximately 100 occupations in the navy during the period 1974-79. Incident cases of testicular cancer (N = 143) were identified in this population and verified through review of original medical records and Medical Board findings. Average annual age-specific and age-adjusted incidence rates were calculated. Expected numbers of cases were derived for each occupational group over this period using U.S. rates provided by Surveillance, Epidemiology, and End Results (SEER), Incidence and Mortality Data, 1973-77, and total Navy age-specific incidence rates. Standardized incidence ratios were calculated for all Naval occupations with at least one case of testicular cancer, and statistical significance was assessed using the Poisson distribution.

Results

This prospective study of occupational risk factors for testicular cancer in this large population demonstrated no excess risk of the disease in active-duty enlisted white male naval personnel compared to the total U.S. population. However, two naval occupations appeared to have significantly increased risk of the disease: aviation support equipment technicians, with a standardized incidence ratio (SIR) of 6.2 ($p = 0.001$), and enginemen with an SIR of 2.6 ($p < 0.01$).

Conclusion

The occupations of aviation support equipment technician and engineman share, along with other Navy occupations, potential exposure to gasoline and diesel fuel or their exhaust products. These results suggest that job-related exposures or activities may be associated with increased risk of testicular cancer for these two occupations. The contribution of specific environmental factors to the development of testicular cancer remains uncertain. Additional well-designed epidemiologic and experimental studies are needed to further explore the relationships between environmental exposures and testicular cancer.

Introduction

Although it is the most commonly occurring cancer in white men aged 25-29, the etiology of testicular cancer is largely unknown (1,2). There are associations with cryptorchidism, other urogenital abnormalities, testicular atrophy and, possibly, with intrauterine exposure to diethylstilbestrol (2-7). Peak age of incidence of the disease is 25-34 years, followed by a gradual decline to a low in adulthood at age 70. Few occupations at high risk have been identified (2), except for reports of elevated proportionate mortality ratios in sawmill workers (8) and significantly high estimated relative risks in farmers and workers in the crude petroleum and natural gas extraction industries (9-12).

The U.S. Navy is one of the largest defined populations available of men at peak ages for incidence of testicular cancer receiving care through a health care system with a centralized, computer-based medical records system. Because of the age and sex distribution of the population at risk and the wide variety of occupational exposures present in the Navy, the Naval Health Research Center initiated a study of the incidence of testicular cancer according to occupation.

Methods

Denominators. A count is performed by the Naval Health Research Center (NHRC) four times each year of all active-duty Naval enlisted personnel from data supplied by the Naval Military Personnel Command and a file of the results is maintained on-line at NHRC in San Diego, California. Counts from this system provided the denominator data on demographic characteristics, occupations, and service history for this study. The period investigated was 1974-79, which was the most recent interval for which complete medical records were available.

Numerators. All hospitalizations in the denominator population were recorded in a medical history file maintained by the Naval Health Research Center. The file was generated by the Naval Medical Data Services Center in Bethesda, Maryland, and is updated annually. It was searched for all first-hospitalizations of white Navy enlisted males with discharge diagnoses of testicular cancer of any type (Eighth Revision, International Classification of Diseases Code 186) during the period of the study.

In order to confirm the diagnoses in the present study, original medical records were obtained from the National Personnel Records Center in St. Louis, Missouri, where such records are stored. When records were unavailable from the Center, they were obtained from hospitals where the diagnoses were made.

When a diagnosis of cancer is made in naval personnel, a Medical Board review is performed. A Medical Board consists of two or more physicians including a specialist in the disease under diagnosis. A Medical Board diagnosis of a malignant disease such as testicular cancer is routinely based on pathologic confirmation. Results of Board reviews which are stored in a computer file at the Naval Health Research Center were used to verify the diagnosis in cases for which pathology records were unavailable. This study is contined to hospitalizations of active-duty

naval personnel. Currently our data include no hospitalizations in retirees or other persons separated from the Navy.

Age-adjustment. Age-adjustment was performed using the indirect method, a technique appropriate to the small number of cases in some age categories of naval personnel. Standardized incidence ratios (SIR's) were calculated using expected values based on annual age-, race-, and sex-specific rates for the aggregate of 10 study areas in the United States during 1973-77. These rates were from the National Cancer Institute Surveillance, Epidemiology, and End Results (SEER) program (1). The Poisson distribution was used to calculate exact p-values and 95% confidence limits on the SIR's (13, 14). All p-values reported are two-sided.

Results

There were 151 cases of testicular cancer ascertained from the medical history file. Of these, 143 were included in the present study. The remaining eight were excluded because, upon review of medical board findings, they were found to have been initially incorrectly classified as having testicular cancer (five were primary cancers in other tissues, one hernia, and one infarcted testis); or did not have sufficient data to support the diagnosis (the case excluded for this reason had testicular cancer listed as a secondary diagnosis with no medical board findings or pathology records available for confirmation). Hospital records were available for six of the eight excluded individuals, and review of these records in each instance supported the exclusion. Microscopic verification of testicular cancer was available on 124 (86.7%) of the 143 cases. The remainder (13.3%) were confirmed by findings of Navy Medical Boards which reviewed each case. The histopathologic reports confirmed the diagnosis for the 124 microscopically verified cases, and showed them to consist mostly of seminomas (32%), tumors of embryonal origin (31%), and mixed tumors (26%) (Appendix A).

Age-adjusted incidence rates of testicular cancer in naval personnel did not differ significantly from those of the United States SEER population, and there were also no significant differences in age-specific rates (Table 1). Peak incidence rates occurred at ages 25-34 years both in the naval and SEER populations. Age-adjusted incidence rates of testicular cancer did not increase with length of service (Table 2).

Two naval occupations were at significantly high risk of testicular cancer: aviation support equipment technicians ($p = 0.001$) and enginemen ($p < 0.01$). Aviation support equipment technicians were at six to seven times the risk expected based on U.S. SEER and Navy population rates for white males of the same age. This result is shown in context with other aviation maintenance occupations in Table 3. Overall, aviation maintenance occupations were not at significantly high risk. Within the category of aviation support equipment technician, high risk was present in mechanical/structural, hydraulic, and unspecified subgroups but not in the electrical subgroup.

Enginemen were at two to three times the risk expected based on U.S. SEER and Navy population rates (Table 4). Enginemen, who tend diesel and gasoline engines, experienced high risk while machinist's mates and boiler technicians, who tend other (primarily non-diesel) propulsion systems

Table 1

Age-specific incidence rates of testicular cancer per 100,000 person-years for active-duty enlisted naval personnel and United States population, white males, 1974-79*

Age (years)	Naval personnel: Person-years at risk	No. of cases	Average annual incidence rate	SEER average annual incidence rate†
17-19	449,890	11	2.4	2.4
20-24	964,189	67	6.9	7.3
25-34	597,022	48	8.0	9.3
35-49	252,995	17	6.7	6.0
50+	4,845	0	0.0	2.8
Unknown	6,888	0	0.0	--
Total	2,275,829	143	--	--
Crude rate			6.3	3.9
Age-adjusted rate			3.7‡	3.9

*Incidence rates based on first hospitalization rates for testicular cancer, International Classification of Diseases, Eighth Revision, Code 186.

†United States population rates were provided by the Surveillance, Epidemiology and End Results (SEER) Incidence and Mortality Data: 1973-77, National Institutes of Health Publication Number 81-2330, 1981.

‡Adjusted by the indirect method using age-specific rates provided by SEER applied to the population distribution of white male enlisted naval personnel.

Table 2

Age-adjusted incidence rates of testicular cancer per 100,000 person-years, by duration of service, active-duty enlisted Naval personnel, white males, 1974-79*

Duration of service (yrs)	Person-years at risk	No. of cases	Crude Average annual rate	Age-adjusted incidence† Average annual rate	95% Confidence limits
0.0-1.9	764,783	33	4.3	3.6	(2.4, 5.1)
2.0-3.9	559,990	38	6.8	3.6	(2.5, 5.0)
4.0-6.9	297,990	27	9.1	4.2	(2.8, 6.1)
7.0-10.9	209,373	17	8.1	3.4	(2.0, 5.4)
11.0+	436,775	28	6.4	3.2	(2.1, 4.6)
Unknown	6,918	0	0.0	0.0	(--, --)
Total	2,275,829	143	6.3	3.7	(3.1, 4.4)

*Incidence rates based on first hospitalizations.

†Adjusted by the indirect method using age-specific rates provided by SEER applied to the naval population distribution.

Table 3

Standardized incidence ratios (SIRs) and 95 percent confidence limits for testicular cancer, by aviation maintenance occupation, white male active-duty enlisted naval personnel aged 20-64 years, 1974-79

Occupation	No. of cases	Person-years	SIR (95% Confidence limits) compared to: U.S. SEER population		Navy population	
Aviation support equipment technician						
Mechanical/structural	2	3,215	7.6	(0.6, 22.2)	8.1	(0.7, 23.6)
Hydraulics	1	1,961	6.4	(0.1, 25.6)	6.8	(0.0, 27.0)
Electrical	0	2,159	-	(-- , --)	-	(--, --)
Unspecified	2	2,616	8.0	(0.7, 23.3)	11.9	(1.0, 34.7)
All types	5	9,951	6.2*	(1.9, 13.0)	6.9*	(2.1, 14.4)
Aviation machinist's mate						
Jet engines	3	24,144	1.5	(0.3, 3.8)	1.7	(0.3, 4.3)
Reciprocating	0	7,945	-	(-- , --)	-	(-- , --)
Unspecified	3	29,105	1.3	(0.2, 3.2)	1.5	(0.3, 3.6)
All types	6	61,194	1.2	(0.4, 2.4)	1.4	(0.5, 2.8)
Aviation electronics technician	4	53,859	0.9	(0.2, 2.1)	1.0	(0.3, 2.3)
Aviation electrician's mate	3	38,509	0.9	(0.2, 2.4)	1.1	(0.2, 2.7)
Aviation boatswain's mate						
Handler	1	11,177	1.1	(0.0, 4.5)	1.3	(0.0, 5.0)
Fuels	0	5,853	-	(-- , --)	-	(-- , --)
Catapult	0	5,917	-	(-- , --)	-	(-- , --)
Unspecified	1	660	23.3	(0.0, 93.0)	27.8	(0.0, 111.1)
All types	2	23,607	2.1	(0.2, 6.0)	1.2	(0.1, 3.5)
Aviation structural mechanic						
Hydraulic	2	25,803	0.9	(0.1, 2.8)	1.1	(0.1, 3.1)
Structures	1	31,979	0.4	(0.0, 1.6)	0.4	(0.0, 1.7)
Electrical	1	12,140	1.0	(0.0, 4.1)	1.1	(0.0, 4.5)
Unspecified	0	1,833	-	(-- , --)	-	(-- , --)
All types	4	71,755	0.7	(0.2, 1.6)	0.8	(0.2, 1.7)
Aviation fire control technician	1	17,813	0.7	(0.0, 2.7)	0.7	(0.0, 2.9)
All aviation maintenance occupations combined	25	276,688	1.1	(0.7, 1.6)	1.3	(0.8, 1.8)
All Naval occupations combined†	143	2,275,829	0.9	(0.8, 1.1)	1.0	(0.8, 1.2)

*Significantly different from U.S. (SEER) and Navy population at p = 0.001 (two-sided test), based on the Poisson Distribution (13,14).

†Includes specialties shown here and all other U.S. Naval specialties (see Appendix B for other occupations).

Table 4

Standardized incidence ratios (SIRs) and 95 percent confidence limits for testicular cancer by ship propulsion maintenance occupation, white male active-duty enlisted Naval personnel aged 20-64 years, 1974-79

Occupation	No. of cases	Person-years	SIR (95% Confidence limits) compared to: U.S. SEER population		Navy population	
Engineman	8	38,908	2.6*	(1.1, 4.8)	2.9*	(1.2, 5.3)
Machinist's Mate	9	115,481	0.9	(0.4, 1.8)	1.1	(0.5, 1.9)
Boiler Technician	4	47,646	1.1	(0.3, 2.4)	1.2	(0.3, 2.7)
All ship's propulsion occupations combined	21	202,035	1.3	(0.8, 2.0)	1.4	(0.9, 2.1)
All Naval occupations combined†	143	2,275,829	0.9	(0.8, 1.1)	1.0	(0.8, 1.2)

*Significantly different from U.S. (SEER) and Navy population at $p < 0.01$ level (two-sided test), based on the Poisson Distribution (13,14).

†Includes occupations shown here and all other U.S. Naval occupations (see Appendix B for other occupations).

did not experience high risks. Naval occupations which did not have significantly high incidence rates of testicular cancer are shown in Appendix B.

Cases in the two naval occupations with significantly high incidence rates had been in the Navy for a median duration of four years, and no case had a duration of service of less than two years (Appendix C).

Discussion

Naval enlisted personnel were not at elevated risk of testicular cancer overall, but two occupations in the Navy, aviation support equipment technicians and enginemen, were at significantly increased risk.

Aviation support equipment technicians operate and maintain the support equipment which provide starting power to, move, fuel, and otherwise service aircraft. These activities may occur on flight decks of aircraft carriers, at aircraft repair facilities, and at airports (15,16). While aviation support equipment technicians do not often work directly with fuels, their equipment is powered by diesel and gasoline engines. Maintenance of this equipment involves exposure to lubricating oils, brake fluids and linings, paints (including chromate-based paints), paint strippers, degreasing agents, and other solvents, and internal combustion exhaust emissions from diesel and gasoline engines.

The occupation of Engineman also had a significantly elevated risk. Their duties include maintaining, overhauling, and operating diesel and gasoline engines used in propulsion of navy vessels. Exposures potentially associated with these tasks include heat, noise, vibration, metal dusts, degreasing solvents, diesel and gasoline fuels, and exhausts from hot engines. It is difficult to explain why incidence rates were high in aviation support equipment technicians and enginemen but low in populations with similar exposures such as aviation boatswain's mates, machinist's mates, and boiler technicians. There may be some as yet undetermined exposure or environmental factor common to these jobs or their training procedures. Common potential exposures of aviation support equipment technicians and enginemen to diesel fuel exhaust, although

not unique to these trades, are of interest and bear further investigation as an exposure hypothesis.

The computerized medical information system provided data on active-duty naval personnel only, so men who were discharged from the Navy were lost to follow-up. Therefore, the high standardized incidence ratios observed in aviation support equipment technicians and enginemen may underestimate the true risks, while relatively low ratios observed in other occupations may be artifactually low. The problem of incomplete follow-up is less severe for testicular cancer, which has a peak incidence rate at ages 25-34 years (1), than for other cancers with peak incidence rates at older ages.

Since we performed a large number of statistical tests, the possibility must be considered that our findings could be due to chance. This is unlikely, however, with respect to aviation support equipment technicians, since the probability value was small ($p = 0.001$), the magnitude of the relative risk was large (6-7 times expected) and the finding was consistent over the three exposure-related subgroups of the four in this occupation (Table 3).

In summary, two occupations in the U.S. Navy experienced significantly high standardized incidence ratios for testicular cancer. These occupations share, along with some other Navy occupations, potential exposure to gasoline and diesel fuel or their exhaust products. Other occupations and the Navy as a whole did not experience high ratios, suggesting that job-related exposures or activities may be associated with increased risk of testicular cancer for these two occupations. The interpretation and contribution of specific environmental factors, such as exposure to gasoline and diesel fuel and their exhaust products, remains uncertain. Further epidemiologic and experimental studies are needed to define the relationships between environmental exposures and testicular neoplasms.

APPENDIX A

Number of cases of testicular cancer, by tissue diagnosis, active-duty enlisted U.S. Naval personnel, white males, 1974-79

			Embryonal tumor with mention of:						
Age (years)	Seminoma	Embryonal tumor NOS*	Teratoma	Seminoma	Seminoma and teratoma	Chorio-carcinoma	Teratoma	Seminoma with teratoma	Other malig-nancies
17-19	0	4	2	0	0	1	1	0	1+
20-24	14	19	15	2	1	0	6	1	1†
25-29	8	11	4	3	2	0	0	1	0
30-34	7	2	0	0	0	0	2	1	0
35-49	11	2	2	0	0	0	0	0	0
50+	0	0	0	0	0	0	0	0	0
Total	40	38	23	5	3	1	9	3	2
Percent	32.2	30.6	18.6	4.0	2.4	0.8	7.3	2.4	1.6

*NOS: not otherwise specified

+Leydig cell tumor

†Choriocarcinoma

Appendix B

Occupations not having significantly elevated incidence rates of testicular cancer, grouped according to major Navy career fields.

Number of cases and standardized incidence ratios, respectively, are shown in parentheses for each occupation.

Administrative and clerical group: intelligence specialist (1, 2.8); disbursing clerk (1,2.3); cryptlogic technician (4, 2.2); storekeeper (4, 1.5); data processing technician (1,0.9); journalist (0,--); legalman (0,--); navy counselor (0,--); personnelman (0,--); postal clerk (0,--).

Aviation-related group: Aviation antisubmarine warfare technician (2, 2.4); aviation maintenance administration man (2,2.0); aviation antisubmarine warfare operator (2, 1.7); aerographer's mate (1,1.6); aviation ordnanceman (2,1.0); airman (2, 0.7); air controlman (0,--); aircrew survival equipmentman (0,--); aviation storekeeper (0,--); photographer's mate (0,--); training devices man (tradevman)(0,--);

Construction group: construction mechanic (2, 3.6); utilitiesman (1, 1.9); builder (0, --); construction electrician (0, --); constructionman (0, --); engineering aid (0, --); equipment operator (0, --); steelworker (0,--).

Deck group: sonar technician (1,4.4); ocean systems technician (1, 2.0); signalman (2, 2.0); operations specialist (5, 1.9); electronic warfare technician (5, 1.7); seaman (10, 1.1); quartermaster (1, 0.6); boatswain's mate (1, 0.3); master-at-arms (0, --).

Electronics and precision instruments group: electronics technician (8, 1.1); data systems technician (0, --); instrumentman (0, --); opticalman (0, --).

Engineering and hull group: Machinery repairman (1, 1.1); firemen (3, 0.9); hull maintenance technician (3, 0.7); interior communications electrician (1,0.4); electrician's mate (1, 0.2); molder (0, --); patternmaker (0, --).

Medical group: hospital corpsmen (7, 1.0); dental technician (0, --).

Miscellaneous group: illustrator-draftsman (0, --); lithographer (0, --); musician (0, --).

Ordnance group: fire control technician (2, 1.8); torpedoman's mate (2, 1.3); gunner's mate (1, 0.4); mineman (0, --); missile technician (0, --).

APPENDIX C

Number of cases of testicular cancer by duration of service, for occupations with significantly elevated SIRs, active duty enlisted Naval personnel, white males, 1974-79

Occupation	Duration of service (years)						
	0.0-0.9	1.0-1.9	2.0-3.9	4.0-6.9	7.0-10.9	11+	All
Aviation support equipment technician							
Mechanical/structural	0	0	0	1	1	0	2
Hydraulic	0	0	1	0	0	0	1
Electrical	0	0	0	0	0	0	0
Unspecified	0	0	0	1	0	1	2
All types	0	0	1	2	1	1	5
Engineman	0	0	4	1	1	2	8
Total	0	0	5	3	2	3	13

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There were 2,275,829 person-years at risk in U.S. Navy enlisted white men during 1974-79. This prospective study of occupational risk factors for testicular cancer in this large population demonstrated no excess risk of the disease in active-duty enlisted white male naval personnel compared to the total U.S. population. However, two naval occuaptions appeared to have significantly increased risk of the disease: aviation support equipment technicians, with a standardized incidence ratio (SIR) of 6.2 (p = 0.001), and enginemen with a

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SIR of 2.6 (p = 0.05). These findings suggest that some environmental exposure or activity related to these occupations may be associated with increased risk of testicular cancer.

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